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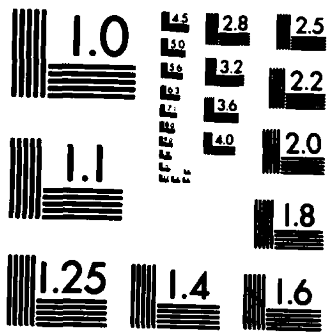
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NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

PROPOSED MANAGEMENT CONTROL REQUIREMENTS
OF THE U.S. COAST GUARD INFORMATION
RESOURCE MANAGEMENT ARCHITECTURE

By

William R. Ashforth

March 1984

Thesis Advisor: William J. Haga

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authorization scheme, (3) a user-oriented chargeback system, (4) pricing to establish an information marketplace, and (5) an information decision tool to assist in user tradeoff decisions between information services. Finally, an integrated system to satisfy these requirements at the Coast Guard District Office level of the IRM architecture is described, based on a Local Area Network system.

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Proposed Management Control Requirements of the U.S. Coast Guard Information Resource Management Architecture

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ABSTRACT

This thesis places the Information Resource Management Architecture of the U.S. Coast Guard in the contagious growth stage of Nolan's model of organizational computer growth. Control is the next stage predicted by the model. The financial accounting basis of EDP chargeback and control systems is examined as a precursor to developing five management control requirements of the IRM architecture. These include (1) aggregate financial accounting for information services, (2) an auditable user access/authorization scheme, (3) a user-oriented chargeback system, (4) pricing to establish an information marketplace, and (5) an information decision tool to assist in user tradeoff decisions between information services. Finally, an integrated system to satisfy these requirements at the Coast Guard District Office level of the IRM architecture is described, based on a Local Area Network system.

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I. <u>THE COAST GUARD IRM ARCHITECTURE</u>

A. INFORMATION SYSTEM PROJECTS

In the early 1970's, the U.S. Coast Guard began automating and integrating the administrative and communications systems which constitute its servicewide Information System. A number of major Information System Projects were identified, each specifying a single functional system, usually vertically integrated from the data-entry field unit through to the Program Manager level at Coast Guard Headquarters. Examples include the Operational Information System project (OPINS), the Personnel Management Information System (PMIS), the Marine Safety Information System (MSIS), and the Standardized Aids to Navigation System (SANDS). Other projects became necessary to support these Information Systems; the Standard Terminal Project competitively bid a requirements contract for procurement of up to 3900 intelligent communications and data entry terminals, and the Semi-Automated Message Processing Project (SAMPS) began computerizing manpower intensive relay points in the record communications network.

B. THE OFFICE OF T

The Paperwork Reduction Act of 1980 mandated a central point of information management in each agency. In 1981,

responsibility for the various Information Projects, and for Information Resource Management Coast Guard-wide was vested in a newly formed Office of Command, Control and Communications (C^3), synthesized from the former Financial Information Systems, Electronic/Electrical Engineering, and Telecommunications Management Divisions at Coast Guard Headquarters. Its staff symbol, (Commandant)G-T, became widespread verbal shorthand and the "Office of T" was born.

C. THE U.S. COAST GUARD INFORMATION RESOURCE MANAGEMENT ARCHITECTURE

An overall schema was needed, to guide the integration and coordination of the various separate information systems and the supporting projects into a servicewide Coast Guard Information System. The Office of T developed and published the Coast Guard Information Resource Management Architecture illustrated in Figure 1. The two primary policy documents supporting and implementing this architecture are the (DRAFT) Command, Control and Communications (C^3) Plan [Ref. 1], and the Command, Control and Communications (C^3) Support Program Plan, 1982-1992, [Ref. 2].

1. Overview and Critical Success Factors

The best overview and explanation of the Information Resource Management (IRM) Architecture is in the C^3 Plan itself:

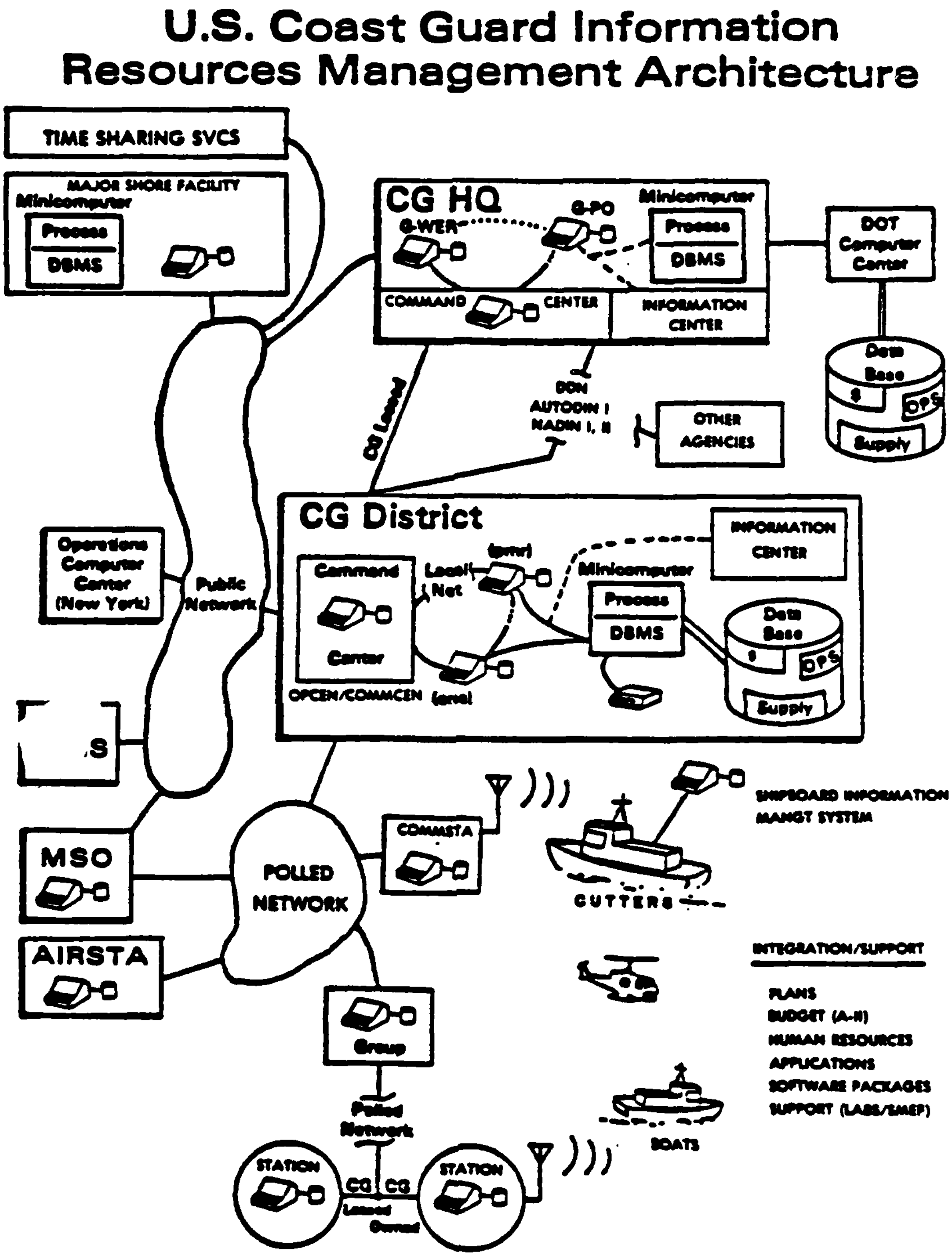

Figure 1. U.S. Coast Guard Information Resources Management Architecture

"Information Architecture Plan.
The first step in effective Information Resource Management is to develop the Information Architecture Plan. This is similar to a business plan in a commercial firm. The information needs and activities of the various **parts of the organization** (emphasis added) are collected and analyzed to determine the manner in which data must be organized to support them. This leads to development of a logical model which describes the arrangement and activities of the organization. This logical model has been found to be quite stable unless the fundamental character of the organization is altered or its missions change radically in a short time. Because the logical model is stable, evolutionary changes can be accommodated.." [Ref. 1: p. 32].

The added emphasis underscores the fact that unless a part of the organization articulates an information need or activity, the Plan cannot address it. Needs of the system overall, "global" needs (like a need for management control) will not enter the Architecture without a sponsor, since they are not the assigned task of any specific organizational element.

The Coast Guard has identified four Critical Success Factors for developing the Information Resources Management Architecture:

1. Intelligent Terminals--to provide a vehicle for local processing, source data entry, and access to the network(s),

2. Data Base Technology--to control the data resource,

3. The Communications Network--to provide connectivity, and

4. Integration--of the parts into a whole. [Ref. 3: p. STSP3]

The emphasis on database technology was not intended to allow the creation of many parallel vertical information systems:

> "The IRM architecture and other policies of the (Office of T) program discourages the proliferation of field-unit terminals connected independently to single-program central data bases. This would be an electronic version of our present uncoordinated, overlapping, manual information system." [Ref. 1: pp. 4-7]

The databases shown, at Headquarters, in the District Offices, and at major shore facilities, are to be shared, multi-purpose databases.

The number of mini-computers shown, coupled with the identification of intelligent terminals as a Critical Success Factor, mean that this is a 'distributed' system. Computing power is placed as close as possible to the people who need to use it. This contrasts with a centralized system where all computing is done at one usually large central computer and user terminals are capable only of data entry and routine inquiries.

2. Classes of Information Serviced

The C^3 Support Plan addresses the three classes of information which the IRM Architecture will have to service: transactional, hierarchical, and local. Figure 2 illustrates the flow of hierarchical information:

> "This figure shows hierarchical information flowing from the smallest unit, to the top of the Coast Guard, and ultimately beyond to both Congressional and Executive recipients. While all three types of information have gray areas of overlap, the essential features of hierarchical are aggregation, and use by management over

time periods of weeks to years. These two features mean that the timeliness of the information is not critical, and the precision and detail of the aggregated information decreases as the hierarchical level increases. Hierarchical information supports the management control and strategic control functions of the organization. [Ref. 2: p. 4-2]

Hierarchical Information

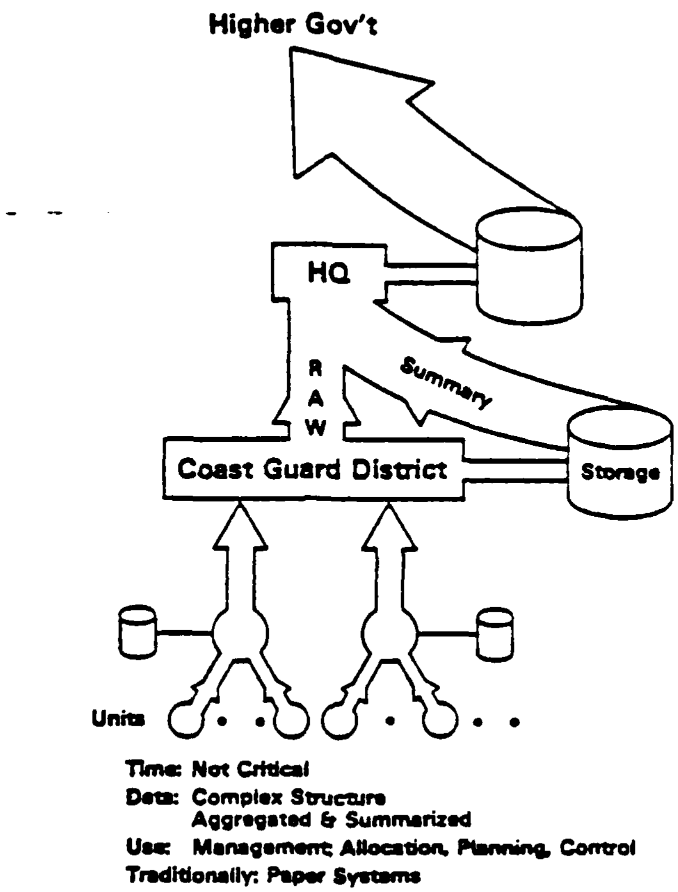

Figure 2. Flow of Hierarchical Information

Transactional information flow is shown in Figure 3 and defined as llows:

"m gure illustrates transactional information, bas .. data groupings which flow intact from point-to-poi ... the organization and usually cause or support rapid activity. In contrast to hierarchical information the precision of transactional information is constant and

> transactions are not usually aggregated. This information type is often found in our present record communications and feeds the operational control function (operating the organization day-in and day-out). A "message MILSTRIP" is a perfect example. Transaction information often has a complex input to hierarchical and this input (and often its duplication) is a significant problem/cost to the Coast Guard." [Ref. 2: p. 4-2]

(The message MILSTRIP mentioned is a telexed supply requisition.) Local information is defined as any and all information that an individual or organizational element chooses to use and keep when it is not institutionally required to do so.

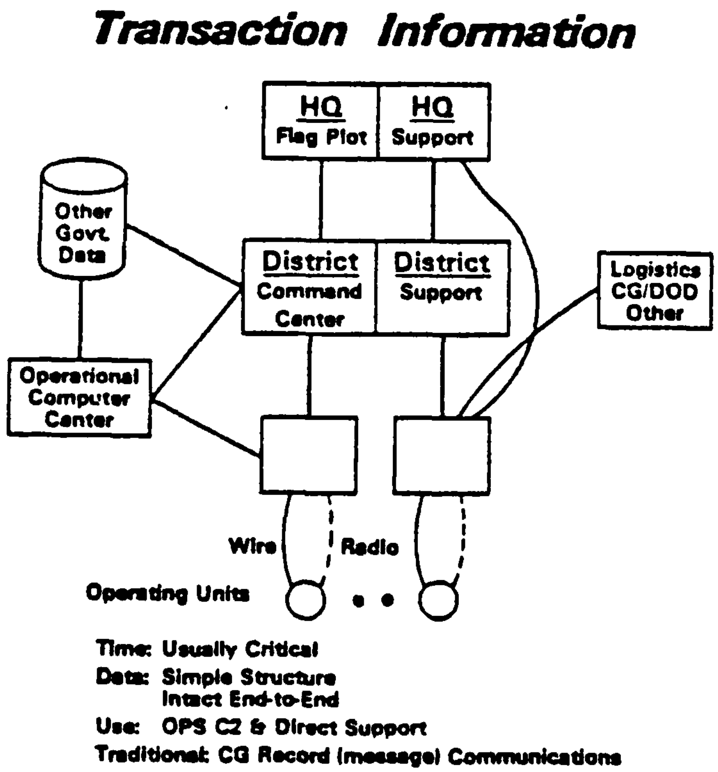

Figure 3. Flow of Transactional Information

3. The Role of the District Office

Central to all three of the figures depicting information flow in the Coast Guard has been the Coast Guard District Office. Situated between the strategic level of Coast Guard Headquarters and the operational level of the field units, the District Headquarters operates at the level of management control. Every major Headquarters Office and/or Program Manager connects to a corresponding District Division or Branch. Districts are responsible for managing Coast Guard resources within a given geographic area (i.e. Fifth District = Maryland, Virginia, N. Carolina). The District Commander (a two-star Admiral) as the principal agent and representative of the Commandant, is responsible for the administration and general direction of district units under his command. Within his District, he is responsible for carrying out the functions and duties of the Coast Guard and for assuring that these duties are performed efficiently, safely and economically. Districts produce the majority of transactional information. [Ref. 2: pp. 1-10] Table I shows the names and locations of the twelve District Offices.

The District Commander's responsibility for local control of Coast Guard resources extends to information resources, too. In 1981, three officer billets (One Commander(O-5), one Lieutenant(O-3) and one Warrant Officer(CWO-4)) were added to the staffs of each of the twelve District

Offices to form the nucleus of an IRM staff. Combined with the existing telecommunications organization, they are meant to evolve into the providers/supervisors of all the information services shown in the "CG District" box within Figure 1. This District IRM staff will operate the Local Area Network and the District Mini-Computer, maintain the District database and provide the Information Center services specified in the IRM Architecture.

Table I. U.S. Coast Guard District Office Locations

District	District Headquarters Location
First District	Boston, MA
Second District	St Louis, MO
Third District	New York, NY
Fifth District	Portsmouth, VA
Seventh District	Miami, FL
Eighth District	New Orleans, LA
Ninth District	Cleveland, OH
Eleventh District	Long Beach, CA
Twelfth District	San Francisco,CA
Thirteenth District	Seattle, WA
Fourteenth District	Honolulu, HI
Seventeenth District	Juneau, AK

D. THE DISTRICT LOCAL NETWORK

While the IRM Architecture and its support plans provide for and define a local network capability for each District, it is not a critical nor a high-priority project. The C^3 Plan defines the Local Network as follows:

> "Within the district office building and immediate surroundings, the local net provides for information distribution through interconnected clusters of Standard Terminals or other existing office information systems. Primary objectives are shared electronic files, electronic

mail, word processing and shared information processing." [Ref. 1: pp. 1-10]

The implementing Support Plan notes that the multi-user capabilities of the Standard Terminal resemble network connectivity, and that clusters of Standard Terminals could be interconnected in a 'message mode'. However, this interconnection and more advanced techniques like wideband channel local area networks "will not be pursued for general Coast Guard use through the mid-80's, although R&D evaluation would certainly be in order" [Ref. 2: pp. 4-10]. The reasons are given in a section titled "Future Technology Impact on the Architecture":

> "A number of promising technologies...have been excluded from this version of the support plan. The basic reason has been one of practical choice; the limited resources available to the program and the need for evolutionary growth dictate that higher risk or non-integrable ventures be excluded...
>
> Local Networks
>
> Mixed voice/data/video has potential payoff, but lack of control of most telephone installations makes this difficult to exploit. Some use of this later in the decade will no doubt occur." [Ref. 2: pp. 4-20].

Each District is responsible for the design, acquisition, operation and maintenance of information (voice and data) networks within the geographic boundaries of the district. [Ref. 2: p. 8-2]. The local net is not regarded as a piece of the IRM Architecture with systemwide impact.

E. SUMMARY

We have given a brief overview of the Coast Guard's Information Resource Management Architecture, and established the central role of the Coast Guard District Office within that architecture. The present status of local networks for the district offices was examined; that "back burner" status is consistent with the C^3 Plan's perception of local nets as non-vital local utilities.

The Coast Guard is still in the process of buying the equipment for the architecture, and at a rapid rate. That rate of growth is examined in the next chapter as an indicator that the Coast Guard will soon need to impose management controls on its servicewide information system. Later we will discuss the type of management controls best suited to an information-processing system, and the advantages of prototyped development of those controls. A standard District Office Local Area Network, coupled with an auditable user authentication and access system, will be suggested as a mechanism crucial to adding management controls to the IRM Architecture.

II. COMPUTER GROWTH IN THE COAST GUARD

A. THE NOLAN MODEL

One widely-accepted framework for understanding and evaluating data processing (DP) within organizations is Nolan's six-stage model for the introduction and growth of the data processing function within organizations [Ref. 4: pp. 76-89]. Figure 4 illustrates the six stages and their characteristics within each of four "growth processes". The climbing dotted line represents the level of expenditures in the total DP budget for the organization.

This model is a refinement of Nolan's earlier (1974) four-stage model based on the S-shaped curve described by most developing DP budgets [Ref. 5: p. 77]. The "transition point" of the later (1976) model, shown in Figure 4 is the point at which a second S-shaped curve takes off. This occurs when the introduction of database technology causes renewed rapid growth of the DP budget. This later model assumes that initial applications do not employ database technology, and part of the increased expense after the transition point is for retrofitting that technology. This assumption may limit the expense curve's direct applicability to the Coast Guard IRM Architecture, given the C^3 Plan's stated emphasis on widespread use of database technology from the beginning in all applications. The

stages and general characteristics of the six-stage model, however, have been validated against experience with more than forty large corporations and should still apply to Coast Guard computerization [Ref. 4: p. 116].

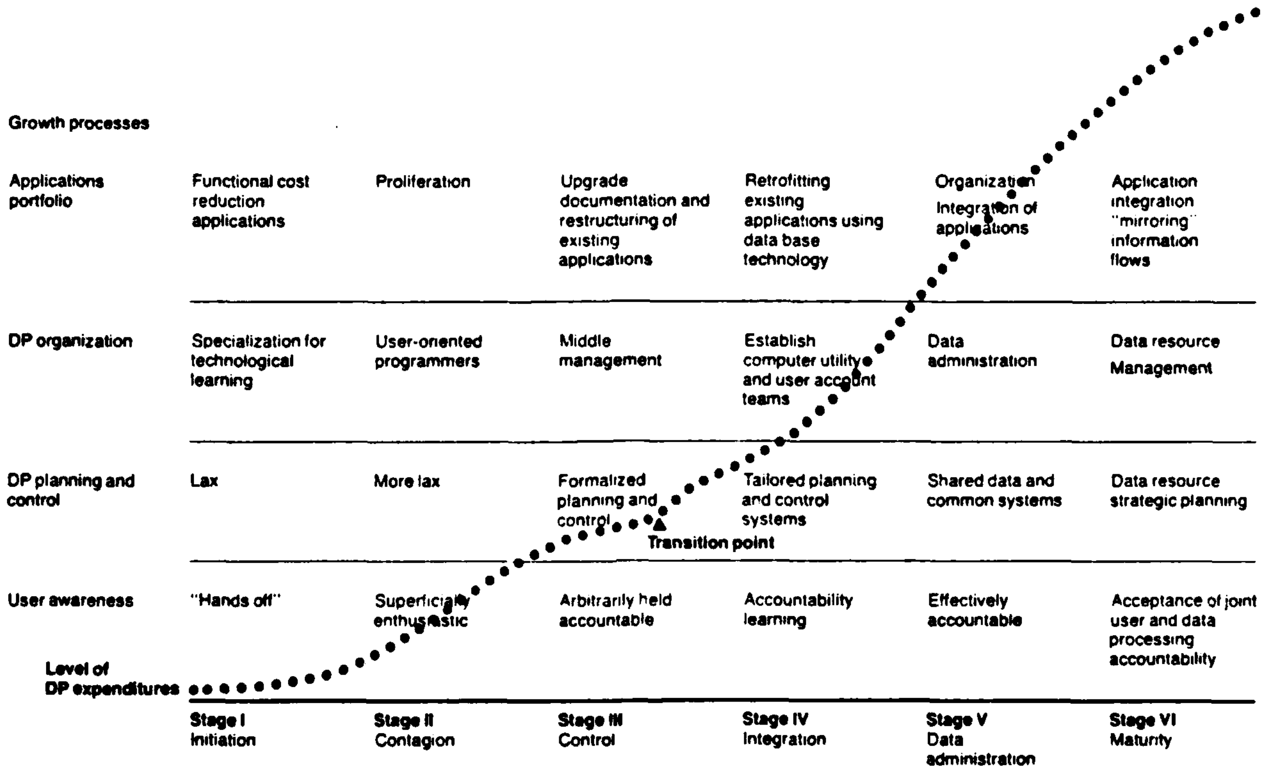

Figure 4. The Nolan Model of Organizational Computer Growth

The process for placing a corporation's data processing within a particular growth stage involves two levels of benchmarks:

"The first step is to analyze the company's DP expenditure curve by observing its shape and comparing its annual growth rate with the company's sales. A sustained growth rate greater than sales indicates either a stage 2 or 4 environment. If data base technology has been introduced and from 15% to 40% of the company's computer-based applications are operating using such technology, then the company is most likely experiencing stage 4." [Ref. 4: p.121]

The second step involves evaluating the company's application portfolio against the investment benchmarks shown in Table II. "For instance, 80% support of operational systems, 20% support of management control systems, and just a faint trace of support for strategic planning systems would show the organization to be at stage 3." [Ref. 4: p. 124].

TABLE II. Applications Portfolio Investment Benchmarks

Stage	Strategic planning systems	Management control systems	Operational systems
1	0	0	100%
2	<1%	15%	85%
3	<1%	20%	80%
4	5%	30%	65%
5	10%	35%	55%
6	15%	40%	45%

B. BETWEEN CONTAGION AND CONTROL

Trying to place the present growth stage of the Coast Guard IRM architecture is difficult, because there are no

accurate total IRM budgets prior to the establishment of the Office of C^3. Many of the operational costs of the Coast Guard-owned record telecommunication system (for example, salaries) are still disguised as overhead expenses. Many powerful computers (up to and including mini-computers) have been bought for word processing, and don't show up in the budgets of the comptroller-based DP departments.

A rough approximation can be made by simply counting all computers, and assuming that in the early stages of growth expenses are linearly related to the number of available processing units. The graph in Figure 5 shows the growth in Coast Guard ADP equipment during the last six years, based on the Coast Guard ADP Equipment Inventory. This inventory, which GSA (the General Services Administration) requires every agency to maintain, represents a current census of any and all equipment including word processors, which performs or supports directly Automated Data Processing. The second curve in the figure shows only those units reported as containing a Central Processing Unit, i.e. a microprocessor; these are the actual 'computers' in the Coast Guard inventory, and they show the same rate of growth as the total hardware curve. Only 40% of the Districts had completed reporting their FY 83 figures at the time these statistics were compiled, but the figures as shown are characteristic of the Coast Guard in general. [Ref. 6] The falloff shown in the first curve may be a result of

incomplete reporting rather than the end of a hardware growth trend.

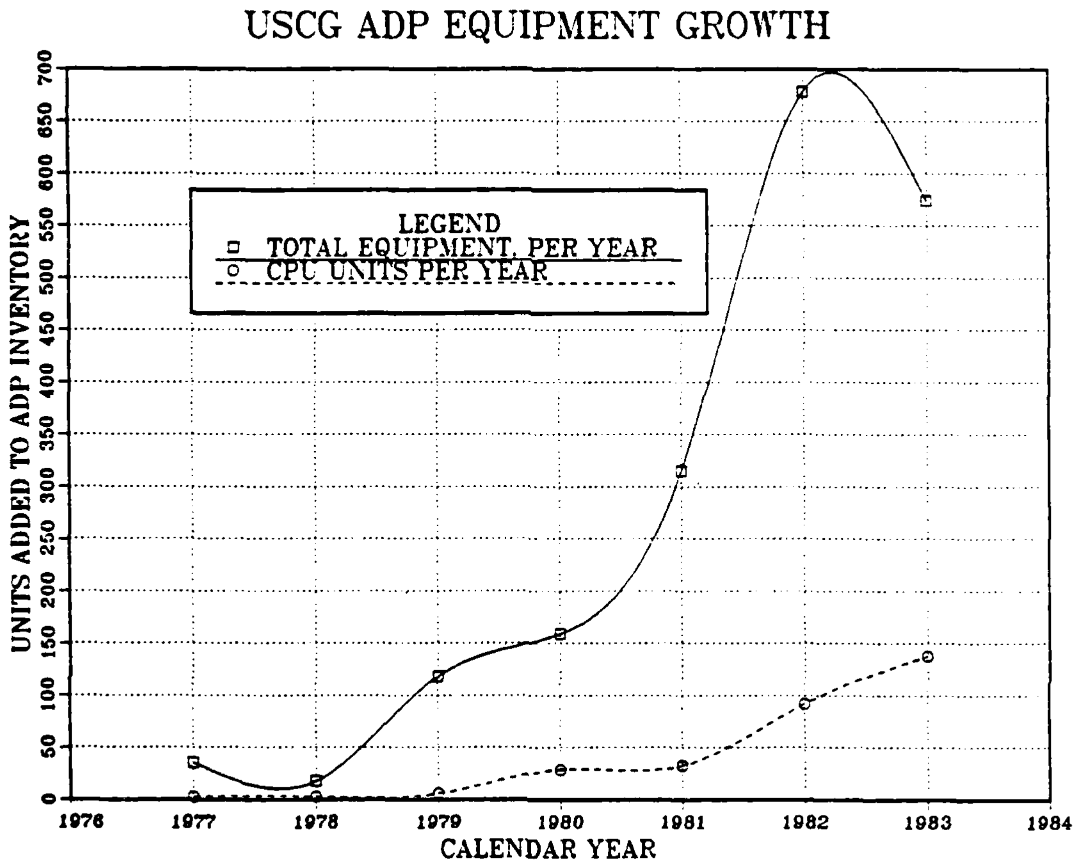

Figure 5. Coast Guard ADP Equipment Growth

Comparing Figure 5 with Nolan's DP expense curve in Figure 4 places Coast Guard computer growth in Stage 2, the rapid expansion phase labelled 'contagion'. This assumes that the Coast Guard's total computer expenditures shows the same rapid growth illustrated for both total equipment and for CPU-equipped units. Since software is not reported in

the ADP Equipment inventory, the actual budget probably shows a higher growth rate than illustrated.

The second step in the placement method is a look at the organization's applications portfolio. Table III is a listing of Major Information Projects of the Office of Command, Control and Communications, taken from the C^3 Support Program Plan [Ref. 2: p. 10-1]. Each project has been categorized by the organizational level it primarily affects. Eleven of these fourteen initial computer projects benefit or improve operations directly. Three of the fourteen improve or support management control. According to Nolan's investment benchmarks in Table II, these figures place the applications portfolio in stage 3, the control stage. The current state of the Coast Guard IRM architecture is therefore between contagion and control.

The rapid growth in stage 2 starts with the spectacular successes of the initial computerization efforts during stage 1. The excess computer capacity usually acquired during the first phase, coupled with the lure of broader and more advanced applications, triggers a period of rapid expansion. Stage 2 represents a steady and steep rise in expenditures for hardware, software and personnel. It is a period of contagious, unplanned growth characterized by growing responsibilities for the EDP director, a loose (usually decentralized) organization of the EDP facility,

and few explicit means of setting project priorities or crystallizing plans.

TABLE III. List of Major Office of C^3 IRM Projects

MAJOR PROJECT	CATEGORY
Marine Safety Information System	Operational
Joint Uniform Military Pay System	Operational
Telecommunications Study - Combine Computer and Record Comms	Operational
Office Automation	Operational
Command Centers	Operational
District Minicomputers	Operational
Shipboard Assisted Maintenance Planning (SCAMP)	Operational
Yard/Supply Center Inventory Control Point Acquisition	Operational
G-T Office Budget System	Management Control
Coast Guard Standard Accounting System	Operational
User Responsibility(Chargeback)	Management Control
Data Management	Management Control
Cobol Conversion	Operational
Operations Computer Center	Operational

This stage often ends in crisis when top management becomes aware of the explosive growth of the activity and its budget, and decides to rationalize and coordinate the entire organization's EDP effort. The dynamic force of expansion makes this a fairly difficult thing to do,

however, and the growth seems to be continuing unabated. Top management frequently concludes that the only way to get control of the resource is through drastic measures, even if this means replacing many systems analysts and other valuable technical people who will choose to leave rather than work under the stringent controls that are imposed during the stage. Firing the old EDP manager is by no means an unusual step.

Often what was a decentralized function and facility is rather suddenly centralized for better control. Often informal planning suddenly gives way to formal planning, perhaps arbitrarily. This stage frequently includes the first formalization of management reporting systems for computer operation, a new chargeback system, and the establishment of elaborate and cumbrous quality-control measures. In short, action taken to deal with the crisis often goes beyond what is needed, and the pendulum may swing too far.

Based on his studies of corporations weathering these computer transition stages, Nolan indicates that for the most part, the problems that arise toward the end of Stage 2 can be greatly alleviated by introducing right at the start of Stage 2 the techniques that companies ordinarily use in Stage 3." [Ref. 5: pp. 79-83]

These Stage 3 controls are shown in Table IV as they were presented in the earlier four-stage model. Also

Table IV. Management Techniques Customarily Applied in Each of the Four Stages.

	Stage 1 Lax management	Stage 2 Sales-oriented management	Stage 3 Control-oriented management	Stage 4 Resource-oriented planning and control
Organization	EDP is organized under the department of first-applications justification; it is usually a small department.	The EDP manager is moved up in the organization; systems analysts and programmers are assigned to work in the various functional areas.	EDP moves out of the functional area of first applications; a steering committee is set up; control is exerted through centralizations; maintenance programming and systems programming become dominant activities.	EDP is set up as a separate functional area, the EDP manager takes on a higher-level position; some systems analysts and sometimes programmers are decentralized to user areas; high specialization appears in computer configurations and operation; systems design and programming take on a consulting role.
Control	Controls notably lacking; priorities assigned by FIFO; no chargeout.	Lax controls, intended to engender applications development; few standards, informal project control.	Proliferation of controls to contain a runaway budget; formal priority setting; budget justification. Programming controls: documentation, standards. Project management initiated; management reporting system introduced: project plan, project performance, customer service, personnel resources, equipment resources, budget performance. Chargeout introduced; postsystem audits. Quality control policies for computer system, systems design, programming, operations.	Refinement of management control system - elimination of ineffective control techniques and further development of others; introduction of data-base policies and standards; focus on pricing of computer services for engendering effective use of the computer.
Planning	Loose Budget	Loose Budget	Strong budgetary planning for hardware facilities and new applications.	Multiple 3-4 year plans for hardware, facilities, personnel, and new applications.

significant in this figure are the Stage 4 controls, specifically the data base policies and standards and the focus on computer services pricing for effective use. Later we will see that these Stage 4 controls are the type which the C^3 Plan would like to implement directly. For now the major points are that the architecture is approaching the control stage, and the early introduction of controls can greatly ease the crisis nature of the transition to Stage 3.

In the next chapter, we will examine the concept of control generally, and the types of controls available for information systems. Some specific recommendations will be made for management controls consistent with the Coast Guard IRM Architecture.

III. MANAGEMENT CONTROL OF COMPUTERS

A. CONTROL IN GENERAL

Management control is a cycle that includes the three stages of goal setting, performance evaluation, and feedback. These three stages of control are illustrated in Figure 6. (1.) Goal setting involves planning, and establishing the goals required for desired performance levels. Measuring and monitoring functions record actual performance. (2.) Performance evaluation compares performance reports with goals. (3.) Feedback information is designed to make corrections in either goals or work activities to bring them into alignment. [Ref. 7: p. 310]

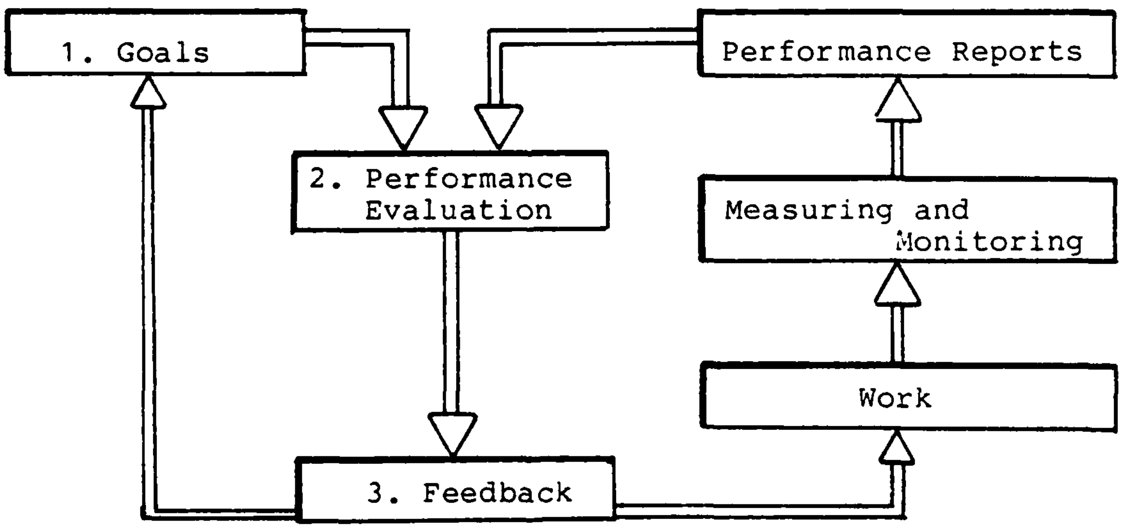

Figure 6. Management Control Stages

This cycle forms the heart of management control systems in most businesses, with the department or division budget

quantifying most of the goals, and the quarterly financial statement providing the performance information to be evaluated against the budget's projections.

B. CONTROL AND CHARGEBACK UNDER CENTRALIZED EDP

Although the expense and the technical complexity of computers has sometimes obscured the point, this general model of management control can be applied to control an Electronic Data Processing department as directly and as well as any other department. Top management has two main concerns in controlling the EDP department:

1. Are we spending too much, or too little, or just enough on EDP?
2. Is the money we have allocated to the department being properly spent?

To answer these questions, and control EDP, top management needs two key structures. The first is a financial reporting system that allows it to do the following things:

1. Review the department's performance on a periodic basis.
2. Compare the department's development against the formal plans for it.
3. Check the functioning of the department's project control systems.

The second is a structure that links the responsibility for various departmental decisions to the operations of the users--ordinarily other company departments. Generally, this

structure is a procedure to account for EDP expenses, either on a charge-out or an overhead basis. [Ref. 8: pp. 70, 83]

As in other business activities, the key performance reporting information is financial; for EDP it is used to track both the department's performance against its own goals (department budget and project control system), and the degree and mix of its support to the other departments (chargeback system). Two weak spots in financial control systems for EDP departments have been project control for software development and user chargeback systems based on computer resources and terminology. Developments in software cost estimation, like Boehm's COCOMO (Cost Control Model), and techniques like structured programming and programmer teams have greatly reduced the difficulty of estimating and controlling software development projects. Computer-oriented chargeback systems which give users detailed reports of the CPU-seconds, main and secondary memory units used, etc., are gradually being displaced by user-oriented systems as computer services become crucial to the "bottom line" of most operating divisions. The reasons for these new systems will be discussed later.

The financial basis of management control of EDP departments has two important implications:

1. As a general rule management control systems for data processing cannot be significantly more advanced than the management control systems used for the company as a whole. Since accounting systems provide the foundation for management control, management control

can only reflect the quality of the accounting system." [Ref. 9: pp. 311, 315]

2. The development of data processing accounting systems is initially an accounting problem rather than a data *processing problem because basic accounting concepts* are most important. Unfortunately, this need for accounting skills is not recognized from the start. Usually, technical personnel play the dominant role in designing the initial DP accounting systems. Rather quickly, however, it becomes apparent that the real problems are financial accounting problems concerning responsibility centers, costing, and allocating costs to responsibility centers. Accounting personnel are then brought into the project.

These fundamental problems seriously hinder the effective design, implementation and administration of computer use chargeback systems. Simply stated, you cannot build a sophisticated control system on a sandy foundation of weak accounting systems. [Ref. 9: p. 315]

1. <u>Evolution of Chargeback Systems</u>

Computer chargeback systems were originally accounting devices to allocate the costs of a very large capital investment among the departments that used it. When most of the processing was large batch jobs, a relatively simple system could price batch jobs according their use of computer resources, as reflected in reports from system monitor programs.

Differential pricing began as an efficiency measure, to boost use and distribute the workload on the computer more evenly by charging less for jobs run during the evening and night shifts. Once the computer was fully scheduled (and more) it became a scarce resource; prices were further

differentiated, and coupled with a priority system for the jobs themselves, to control and monitor the competition for the now-scarce computing time.

An important transition was made as the organization's goals changed from efficient (full use) to effective (most necessary jobs) use of the computer system. The management control purpose of the chargeback system was expanded to include shaping the behavior of users. Information not necessary to proper computer operation, i.e. job class and priority, was added to jobs and the operations monitoring programs were changed to record it. The range of choices available to the user department grew, but the costs of those choices were determined by the EDP department, and still largely based on recovering the actual costs of equipment and operations.

A priority system and a single scarce resource implies that some jobs never get scheduled. An alternative to the central EDP department came about as decreasing equipment costs allowed time-sharing and computer service bureaus to develop, and it became theoretically possible to get all computer projects accomplished without a major capital investment decision. Rather than competing for use of the single company computer, projects could be subjected to the same cost/benefit analysis used for other business projects in the firm. For the first time, make-or-buy analysis (whether to do a job yourself or buy it from

someone else) could be applied also. This open market of competition to the central EDP facility radically changed the management control uses of the chargeback system again. An open market fosters competition through price, and allows the chargeback prices to be used to judge how efficiently the EDP department delivers computer services. The responsibility for effective use of computer services was almost totally transferred to the user departments, as the organization's experts on the business benefits of a particular application. Currently organizations require the chargeback system to isolate as completely and clearly as possible, the actual costs of the specific application. The prices must be refined to eliminate the variances due to the operation of the computer department from the actual consequences of the "consumer's" use. This provides to the user the best cost information with which to make a sound cost/benefit decision for the company. Chargeback is also used to evaluate the user for efficiency in the use of computer resources in accomplishing his or her business mission.

Both the financial accounting and the computer-resource accounting abilities of the organization have had to mature to accomplish the expanding management control purposes of chargeback in an increasingly complex environment. As the responsibility for effective and efficient use of computing resources shifts to the user

departments, they have demanded that charges be expressed in units they can understand and effect. Applying industrial accounting techniques allows the allocation of the resource costs per job (CPU-seconds, tape and disk drive hours, main and secondary memory) to be priced out as standard costs per work unit (cost per check, per invoice, per personnel record update). These standard costs can be accumulated by section or office within a department to support a finer degree of control.

The implementation of management control through chargeback is a dynamic process. Studies of the process have developed four criteria for judging chargeback systems:

1. Understandability:
   To what extent can the manager associate charge-out costs to the activities necessary to carry out his or her tasks?

2. Controllability:
   To what extent are the charges under the control of the user?

3. Accountability:
   Are costs and utilization of computer-based systems included in the performance evaluation of the user?

4. Cost/benefit incidence:
   Does the user responsible for task accomplishment also receive the chargeout bill? [Ref. 9: p. 317]

In addition to evaluation criteria, these studies have produced several vital general observations. One mistake frequently observed in designing an effective system is to impose sophisticated controls upon organizational units that are not "ready". The organization unit is not

ready if controls hinder its operation or if personnel cannot clearly see the relevance of the controls to their problems. [Ref. 9: p. 311]

Chargeback systems also evolve. They initially are directed at high-level managers. Summary data processing bills are sent to divisional controllers without much information on the charges being conveyed to end users. With maturity, the charge-out systems become more sophisticated and permit detailed bills to be sent directly to low-level users. It is important that a chargeback system does evolve through successive phases so that users and DP managers can learn how to interpret and use the information. It is especially important that the means for accountability be coordinated with the expectations for accountability. Users resent charges for systems they cannot affect.

Management's objective is to develop a strategy that will increase the maturity (and effectiveness) of the charge-out system at an appropriate pace for the major user groups. It is likely that several charge-out strategies may be required for the different user groups. [Ref. 9: p. 318]

2. Summary

In the process of developing management controls for the Coast Guard IRM architecture, the lessons we can transfer from the experience of centralized EDP include:

1. Management controls for EDP are financial in nature and thus comparable to the controls on other departments.

2. They have a stronger base in good accounting than in technology. They can therefore be no more complex than the accounting and management control systems of the rest of the organization.

3. A chargeback system is essential to management control of EDP departments, and eventually, EDP users.

4. Chargeback schemes grow and mature. Management must develop a strategy to manage this process at an rate appropriate to the major user groups, and to changing management control needs.

An important although not obvious point is that the competition for computer services described here takes place in essentially a single arena. The goods and services (reports, database queries, CPU cycles) are almost perfectly interchangeable, between the daytime on-line version of the payroll and the late shift batch run of the same program, even between the in-house product and the service bureau version of the same printout. Competition by price is a logical basis of comparison of substitutable goods in the same open market, whether in keeping the EDP department 'honest', or in the user's trade-off between alternate ways of implementing a given project. As a management control technique, it assumes that everyone knows all the prices (perfect knowledge) and knows the substitutability of various goods, so changing the relative pricing should logically effect behavior.

C. EXPANDING EDP TO IRM AND REFINING CHARGEBACK

Information resource management obviously entails more than controlling a centralized data processing center. The

Coast Guard has defined it to include all information processing: transactional and operational information, office automation as well as data processing and voice and data telecommunications. This expansion means it includes what Strassman defines as a second major sector of information processing, "administrative processing", which he says is largely ignored by information-processing executives:

> "While it accounts for the largest and most frequently used set of tools and facilities for handling information transactions, it is rarely aggregated under a single expense heading. It includes everything from typewriters, word processors and dictating equipment to telephone and Telex networks, recording devices, copiers and duplicators,facsimile transmission devices, microfilm equipment, and even such relatively mundane necessities as office supplies, mail, and simple filing systems. These administrative tools are quite diverse and often isolated from one another, so that the expense involved in their use tends to become highly diffused. Historically, little trade-off has been possible among such individual office "technologies". [Ref. 9: p. 295]

No organizational unit is responsible for integrating these noncomputer aspects of information handling, but the fastest expense growth in the office environment is occurring here. If an organization intends to control rising expenses for 'white-collar automation', information systems management must expand to include careful expense accounting for these diverse office technologies. This control must also be in some flexible automated form, since the future volume of information transactions is uncertain, as are the relative importance of various cost elements, rapid changes

in technology, and shifting attitudes toward office automation by labor and government. [Ref. 9: p. 296]

In addition to the increased size of the total information system, and a greatly increased number of transactions, we are annexing an area where the costs are so spread out as to be hard to accumulate. The management control job will be further complicated by the lack of direct tradeoffs between the products of some of the subsystems in the architecture. For a price-based control system to work, some indirect measure of substitutability among the systems will have to be developed. Considering the massive volume of transactions, the entire control system must be eventually completely automated. It is more appropriate to call it an 'information pricing system' rather than 'chargeback'. A good encapsulation of the ultimate goals of such a control system is Strassman's list of the objectives for a top information executive in today's business environment:

* Ensuring the integration of data processing, administrative processing, and office labor productivity programs.

* Instituting accounting, cost-control, and budgeting innovations that will subject all information systems overhead activities to the disciplines traditionally applied to direct labor.

* Subjecting office labor automation programs to analyses comparable to those applied to all other forms of capital investment.

* Conceiving organizational designs that will permit information to be handled as a readily accessible and

easily priced commodity rather than as a bureaucratic possession.

* Creating within the organization an internal market for alternative information systems products, so that trade-off decisions, even technologically complex ones, can be decentralized into the hands of local user management.

* Fostering a technique of pricing that will allow decisions on introducing new technology, or abandoning obsolete technology, to be made on a decentralized basis.

* Installing and monitoring measurement methods that will protect improvements in productivity achieved by automation programs.

These are the ultimate, not the immediate, goals of any proposed management control system for a complete information system. By examining the purposes and evolution of EDP chargeback, and projecting the requirements for information systems control for the future, we have set the stage for considering specific recommendations for management control requirements of the Coast Guard Information Resource Management Architecture.

IV. CONTROL REQUIREMENTS OF THE ARCHITECTURE

A. SUGGESTED MANAGEMENT CONTROL REQUIREMENTS FOR THE COAST GUARD INFORMATION RESOURCE MANAGEMENT ARCHITECTURE

To pave the way for a smooth transition to the control stage of computer growth, the Coast Guard should soon develop the information or systems necessary to meet the following five requirements:

1. Aggregate financial information
2. Auditable identification of users
3. Meaningful chargeback system(s)
4. An 'information marketplace'
5. An information decision-making tool

Each of these will be explained in detail below. These suggestions assume that major hardware subsystems (i.e. mainframe or minicomputers, communications network interfaces) will have resource-accounting monitor programs installed.

1. Aggregate Financial Information

Since the primary support of budget-based management control systems is good accounting, the Coast Guard accounting system should be modified to allow for information costs to be aggregated, both by organizational unit, (i.e. a Division or a Section of a District Office) and by a project identifier (Project D17-21, Develop

Operations Database). The current joint project of the Office of C^3 and the Office of the Comptroller to develop and automate a Coast Guard Standard Accounting System should address whether a separate Operating Guide (OG) or a Subhead is needed to identify information funds, or whether an Object Code identifier holds enough information and flexibility for complex financial reporting. A unique identification of the funds as information funding, along with a system or project identifier, and a capability to retrieve by organizational subunit will support the reports necessary to monitor and control both the IRM function and the end users. An identifying field of this sort would support "information budgets" easily when cost control becomes necessary. It also would function partially as a common denominator for the information services, supporting tradeoff decisions and preserving information savings for the information-efficient manager to spend on other information services.

2. Auditable Identification of Users

A basic concept in any branch of accounting is the audit trail, the ability to reconstruct for any entry in the record, the series of transactions that originated or altered it. Conversely, for any original entry or transaction the audit trail tells you which permanent records it affected. The financial nature of management control that we have developed insists that the user

authorization and identification structures used in the various subsystems of the IRM Architecture be auditable, that they maintain or can reconstruct a complete audit trail from end user to ultimate database.

In addition to insuring auditability of IRM financial accounting and chargeback, an auditable user identification scheme reinforces system security, and by increasing the perceived threat of apprehension, strengthens the policy and procedure controls of the system. Another perception that benefits from secure identification is the perceived equity of the chargeback system. Since not all users nor all applications can be equally important to the organization, the most a chargeback system can hope for is "perceived equity". [Ref. 10: p. 260] An auditable access scheme documents for the user that the charges received did originate in his/her department, and reinforces a perception of equity.

The high degree of telecommunications in the IRM Architecture, with some systems open to several networks, means that simple password systems will not provide adequate protection. This communications vulnerability is aggravated by the periodic transfers of the Coast Guard's military personnel. User accounts are often only logical partitions in the same computer, accessed by a network common to several physical user sites. Passwords could not protect a filespace from an old authorized user at a new duty station.

Some hardware identification (such as a terminal identifier) at least needs to be added to all systems. To preserve the audit trail, space for this terminal identifier and the user i.d. needs to be designed into network message headers. Once the access and message header configurations are frozen, the incremental costs of adding security and auditability will be much higher, as will the temptation to forego the expense and rely on procedures alone for control.

3. Meaningful Chargeback System(s)

The goals of a meaningful chargeback system are to express the costs of information in the terms of the user's units of work, and to understandably identify, accumulate, and return to the user all information costs associated with his/her work operations. Ultimately, such a system would completely satisfy all four of the evaluation criteria listed in Chapter III. The system administrative overhead necessary for the financial reporting and user identification requirements just discussed will also enable a user-oriented chargeback system to be implemented, as a third benefit to offset those same costs.

One possible implementation of such a chargeback scheme is as an interface accounting program, which would accept inputs from the various subsystems, sort them by user identification, cross reference with user budgets and transaction totals, and produce a average cost per transaction type, detailed to identify information subsystem

costs. Such a system would have to be both modular and flexible by design, to allow subsystems to be added and removed as configurations and technology changed. Locating it as close to the user as possible in the architecture would allow all higher systems to run "off-the-shelf" computer resource monitors, modified only enough to record both user and terminal identifications.

4. An Information Marketplace

Users could make trade-off decisions rather easily when the services were all available from one source (the EDP department), or even were direct substitutes for each other (service bureau versus in-house, for the same product). The number of alternative information services, and the number of ways to obtain them are both growing rapidly, even within the unifying device of the IRM Architecture. Strict dollar cost is not an accurate basis for comparison or competition any longer. The C^3 Support Program Plan identifies timeliness, quality (accuracy and precision), quantity, and cost (of collection, transmission, storage, and use) as components of information of interest to the Coast Guard [Ref. 2: p. 5-1]. Few among user management will have the information judgement to evaluate a straight cost for service against its value along those four parameters. Some set of adjusted prices, or factors by which to weight costs will be necessary to create an information marketplace where products and services of the

various information subsystems can be directly compared. The user is the expert on the benefits to his program that the service will provide; the architecture will have to provide him/her a basis for properly comparing and evaluating the costs of that service, if the Coast Guard intends to hold the user accountable for an effective and efficient decision. This could be as simple as a set of adjusted prices for a generic example, (i.e. the average letter costs 2.6 times as much as a message) coupled with substitution rules and judgement criteria (letter vs message: consider speed and security), or as complex as a database of currently-calculated weighting factors available to an automated decision-making tool.

5. An Information Decision-making Tool

In addition to creating the information marketplace by publishing a list of adjusted or general substitution prices, the system should provide a consumer's guide to proper shopping. This will insure the most effective accomplishment of the IRM architecture's management control mission through pricing and chargeback.

It is to the Coast Guard's advantage to have users making the most effective and efficient information decisions possible. The user/manager is best qualified to make the cost/benefit comparison of alternative information services. The goal of the chargeback system is to provide that user/manager the best possible cost information to

combine with his best possible benefit knowledge, and then hold him accountable for the decision. The manager will develop an information decision 'support system' for these decisions, if only a set of notes on how the last one was done. There will be a faster learning curve and more consistent results if the IRM architecture recognizes this and supports the manager's decision by some standard means.

A published set of suggested procedures (cookbook guide) could couple with a price list to produce trade-off decisions standard enough to be comparable and reproducible. Eventually, a spreadsheet program able to access a substitution price table, or to calculate weighted prices from the chargeback information could be developed. Some project lifecycle guidelines could be incorporated in such a program painlessly. In whatever manner, some decision support should be developed. To have management control through pricing and chargeback work properly, we assume the goods are substitutable, and the consumers have perfect knowledge of both price and substitutability. We further assume they will make the logically best choice. These last two suggestions for the IRM architecture (information marketplace and decision support) attempt to insure those assumptions are met, and to assist the user in the choice best for his unit and for the Coast Guard.

B. IMPLEMENTATION SUGGESTIONS

1. The Standardized User Interface

In a system as large and as distributed as the Coast Guard IRM Architecture, operating under Federal rules for competitive procurement, it is almost certain that the various subsystems (both hardware and software) will be developed separately. Unless specifically controlled, the interface each subsystem presents to the user will vary from one subsystem to another. The interface includes such things as the location and size of text, the method of specifying commands (numbers, letters, words), the method of presenting options (text or a menu) and other guidelines to the user for input.

At the extreme range of variation of these interfaces, an identical command will have different meaning and effect in two different systems which a single user routinely accesses. (For example, STOP in one system halts text scrolling on a display screen, in another it ends the session.)

Specifying a standard user interface to be maintained by all subsystems simplifies learning and use of the entire coordinated system greatly. It provides a mechanism for the smooth introduction of change as well, by preserving for the user as much of the familiar as possible as an environment for the new function or command. A major advantage is that once an effective user interface for a

given system or subsystem is developed, that design can be 'frozen' from change for a while, preserving the effectiveness of the interface through other system changes. We have seen that chargeback and management control systems change to match the maturity and growth of the information system overall. Expecting that change, a standard user interface should be developed and incorporated in all automated portions of the control structure of the IRM architecture.

2. <u>Prototype/Iterate/Adapt</u>

We have already characterized portions of the proposed management control structure for the IRM architecture as a decision support system for the user in purchasing information services. That tool could also function as a decision support system for the organization in choosing those prices which will produce the desired user behavior. A proposed new price for a single service could be tested by running the user's decision tool program with that price as an input. The price could be adjusted until the desired decision was reached, or the model could be run 'backward' to determine the specific price change required. Developing the Coast Guard IRM management control structure shares much with the development of decision support systems, as characterized by Keen [Ref. 11: p. 132]:

* Neither the user nor the builder can specify functional requirements in advance.

* Users do not know, or cannot articulate what they want and need. They need an initial system to react to and improve upon.

* The users' concept of the task and perception of the nature of the problem changes as the system is used.

* Actual usages (of DSS) are almost always different from the original intended ones. In fact case studies show that many of the most valued and innovative uses could not have been predicted when the system was originally designed.

* Intended users of the system have sufficient autonomy to handle the task in a variety of ways, or to differ in the way they think to a degree that prevents standardization of process.

Several studies [Refs. 12, 13, 14] suggest that the best method for designing a system in such a loosely-defined situation is by an iterative design process. The steps in the process include:

1. Identify an important subproblem.
2. Develop a small, but usable system to assist the user.
3. Refine, expand and modify the system in cycles.
4. Evaluate the system constantly.

This design approach starts with an prototype system, which adapts in successive iterations to the user's and the designer's experiences. By definition it is flexible and adaptable. This method is proposed as a design alternative to classic system life cycle design, which attempts to define all possible system requirements in the initial study phase, and then delivers a specific system to satisfy those requirements. A major change in such a system requires a return to the study phase and a new set of requirements. An

advantage of iterative design is that several different small prototypes can be run in parallel, and evaluated before selecting a standard model for system-wide implementation testing.

The various programs and systems to satisfy the management control requirements previously listed, with the single exception of the structure for aggregation of financial information, should be developed using this iterative design methodology. The complex and ill-defined nature of the control problem, plus the need for the control system to continually grow, support using a method focused on development of poorly defined and flexible systems.

The appropriate place to initially install the prototype systems to begin satisfying the proposed management control requirements is at the level of the District Office, for a number of reasons which will be fully developed in the next chapter. An implementation incorporating several of the necessary control elements into a District Office Local Area Network will also be described.

V. THE DISTRICT OFFICE LOCAL AREA NETWORK IMPLEMENTATION OF MANAGEMENT CONTROLS

A. WHY THE COAST GUARD DISTRICT OFFICE

The major reason for placing the management control structures of the Coast Guard IRM architecture at the level of the District Office is to remain congruent with the rest of the organization. The District Office exercises management control over every other operational program and staff function. In the financial chain, for example, the District Comptroller approves operating unit budgets with the concurrence of the district program manager. For administrative information control, all official correspondence and reports enroute from operating units to Headquarters must be endorsed by the district program manager in the chain of command for the originating unit. Management control of the information program logically belongs at the District Office as well.

The District Office is the level at which hierarchical information is aggregated for forwarding to Headquarters, as illustrated in Figure 3. The Coast Guard District block in the IRM architecture (as illustrated in Figure 1) is also the system node with the most connections to other networks and units. This center of connectivity is the best place to

easily collect a maximum amount of data about computer and communication systems usage.

With the installation of minicomputers in each of the twelve Coast Guard Districts scheduled for FY 86, the processing power will be available to run the monitor, accounting and user identification programs necessary to the prototypes. There will also be sufficient data storage capacity available to accumulate an historic data base on usage and usage patterns for information services.

People resources are at the District Offices as well. The District IRM officers are in place with the knowledge to run and evaluate the prototype control systems. The other district program managers make up a team of knowledgeable control-oriented managers ready to fully test the various prototypes and suggest changes. Because of these program managers, the IRM control problem at the District office will be the most difficult, and therefore the richest in terms of potential learning about user requirements.

The district program managers are management controllers themselves, of units and programs for a geographic area. A major mission of the district IRM staffs will be teaching them how to use information services in exercising that management control. As the need for control of the IRM architecture grows, the district IRM staff's job will become controlling these other controllers, and through them their units, to promote more efficient and effective use of

the architecture overall, and an early start on the problem may ease a difficult transition from teacher to tax man for the district IRM staff later on.

B. WHY THE LOCAL AREA NETWORK

Throughout the thesis we have been attempting to develop the need for, and requirements of, management control structures for the entire Coast Guard IRM Architecture, as one large but integrated system. That integration is an express intention of the Office of C^3:

> "The IRM architecture and other policies of the (Office of C^3) program discourages the proliferation of field-unit terminals connected independently to single-program central data bases. This would be an electronic version of our present uncoordinated, overlapping, manual information system." [Ref. 1: pp. 4-7]

While the management control requirements we have developed are applicable and useful to any of the single vertical information systems within the overall architecture (e.g. Personnel Management Information System (PMIS), Marine Safety Information System (MSIS)), they are also powerful devices for logical integration of these separate systems into a single architecture, from the user's point of view. To accomplish this integration, the controls must be applied, or at least appear to the user to be applied, as a single part of a unified architecture.

To those who have read the various planning and support documents of the IRM architecture, it is a logical whole, and its integration of systems is obvious. However, if the

user of the system confronts a different interface screen and different sign-on procedure for each of the subsystems (PMIS, MSIS) he or she uses, and if each of these subsystems returns a separate chargeback bill which the user must "integrate" with a hand calculator, then the IRM architecture has not achieved its 'single system' goal.

The single physical device connecting all the information resources of the CG District block, in the Figure 1 illustration of the architecture, is the 'local net', the District Office Local Area Network (LAN). When fully operational, this local net will be the port through which all district information services can be accessed. Application of the IRM architecture's management controls through the LAN uses its physical integrating power to create and reinforce the logical unity of the overall system. It collects the separate shopkeepers of the individual information systems into an information marketplace where control through pricing can be most effective for the entire architecture.

C. MEETING THE REQUIREMENTS WITH THE LAN

Each of the management control requirements will be discussed separately below for a configuration that assumes an operating local area network is in place.

1. Aggregate Financial Information

While no physical program or device is needed to satisfy this requirement, the necessary changes to the financial accounting structure will need to be defined before the design configuration is frozen for other, automated portions of the control structure. The accounting changes may add extra data items, or expand the size of existing data items, throughout the architecture, to ensure that the information necessary for the audit trail and for project-level aggregation of information costs is maintained. For example, adding a field to a message header to hold a project identification may change hardware and software throughout the system.

2. Auditable User Access

The District LAN is the IRM system entry port; user and terminal identification should be demanded and tested here. This begins and maintains the audit trail at the point of first entry for all users at or below the District Office level. Once the user is authorized access to the network, the network can then access all subsequent communications links and computers, providing the appropriate access information and identifying the user and terminal to the other systems.

This eliminates the problem to the user presented by a multitude of different access procedures for each of the different intermediate services. For example, to access the

Operational Information System computer in New York, the user must dial the local number of GTE TELENET, and comply with their sign on procedures, providing an account number and a password, then requesting the connection. Once connected to the OPINS computer, a minimum of three more i.d. and password combinations are necessary to reach a working level successfully. The importance of the information involved justifies the security, but the tedium to the user has prompted the OPINS configuration managers to authorize an programmable modem (computer communications device) to be installed in their systems. This modem then allows a user to access the remote computer with the push of a single button. The protocols, identification numbers and passwords are all programmed into the modem, and automatically presented to the necessary subsystems. The audit trail is lost--the system cannot record a unique identification (number, password and terminal i.d.) of whichever user pushes the button. Satisfying the requirement for auditable user identification at the initial access to the District LAN would preserve the utility of automation such as this while not losing security or auditability. Overall system security would actually increase by recording the user identification data provided to the LAN by people repeatedly attempting access to systems for which they were not authorized.

This automation provides more than user convenience. The various information subsystems (PMIS, MSIS) are reached via different communications networks, and once accessed have different password procedures and file structures. If the user must record and maintain the access information for each system separately, then the fact of their separateness as subsystems is reinforced each time any subsystem is accessed. If the various subsystems all appear as selections on an "Access Menu" once the user has signed on to the LAN, they are reinforced as parts of a unified system.

One alternative to LAN user identification data capture is distributing unique identifiers and passwords for all individual units at the destination end, (i.e. OPINS) and auditing use for chargeback there. Administering both a billing and a password maintenance system adds administrative overhead at the highest level of the architecture. Collection of the usage data is removed from the level of enforcement of the charges, and the user's perception of autonomy and system equity may suffer.

3. Meaningful Chargeback System

A meaningful chargeback system provides information useful to the user. While the initial chargeback systems will not be refined enough to track each user in detail and express all costs in terms of the user's work units, the 'useful information' goal can be preserved during the iterative development of the chargeback system, and this

function, too, can reinforce the concept of unity for the architecture.

For example, consolidating and keeping track of the separate information service charges against a user division's total information budget (telephone, Xerox, microcomputer supplies and maintenance, etc.) would be useful to the user while reinforcing logical integration of these (now) diverse services. A program available through the network to extract such accounting data for a given user, producing an up-to-the-minute status for his/her information budget would do much to associate resource accounting with information rather than bills. Such a program would only require a standard query to the accounting database on the District minicomputer. Having the program available through the LAN allows IRM managers to track how frequently the program is used, as a rough guide to the 'information awareness' of the entire staff or a given division.

Often, before actual charges for system use are levied, the chargeback system is used as a device to notify users of the level and cost of the information service they consume. [Ref. 15: p. 114]. As each of the various subsystems gains resource accounting and reporting capabilities, their usage data could be added to the chargeback or 'budget status' report. The transition to actual charges would be a gradual change, and the user could

judge both charges and usage data in context. The single budget report (bill) would reinforce the logical system unity, and the LAN could make it a recordable and easily accomplished event.

4. An Information Marketplace/Decision Tool

The marketplace concept is an attempt to identify the functions and costs of the information services, and to identify the substitutions possible between them. It intends to develop in the user a holistic view of information processing and to influence his/her conduct with pricing. If functionally similar services are available through the LAN as a series of substitution lists or function menus, the physical presentation strongly reinforces the logical integration and substitutability the management controls are trying to develop. Rather than remembering that electronic mail and/or record communications messages can substitute for hard copies on letterhead stationery, the user chooses one or the other from an "Output Menu" and the network delivers the user's document to the appropriate device. Or, the user could select several options and compare their prices before committing the document for delivery. The decision tool could be incorporated as a "How Much?" command available to compare possible choices in terms of information dollar costs. Not all of the options need be physically connected to the LAN. Telephone calls are a valid substitute for letters, but may not be directly available

through the system. As long as their prices appear in the decision tool models, and they are listed as alternates on the appropriate function (Input, Output, Send, Analyze) menu, services like the telephone and the stand alone microcomputer will be included in information marketplace, and therefore subject to the management controls of the IRM architecture.

Again, if the information decision tool is available through the LAN, its use can be recorded as measure of information awareness. If the LAN can access the separate communications and information subsystems to connect users, it can also access those subsystems to get current pricing and usage statistics for incorporation in the information decision tool models.

The function menus insure that the user is reminded of the possible substitution alternatives at the time the choice is made. The decision tool insures that the best possible cost information is available to support the choice. Satisfying these requirements at the District LAN interface insures the choice is among all the options and all the information services available to the user's purpose, within the whole architecture, as opposed to only those choices available within a given information subsystem.

5. Standard User Interface

Although not listed as a management control requirement, the idea of a standard interface between the IRM architecture and the user is another physical way to strengthen the user's perception of the architecture as a unified system, as opposed to a collection of systems. It could easily be implemented in the proposed LAN environment by using a standardized interface in the programs designed to satisfy the control requirements.

A hidden advantage to this approach is that it minimizes expense; once the interface is designed, the same specifications are used for each subsequent program. Only the information presented on the screen changes; the location of status information and instructions, the type of selection (e.g. by letter, from a menu), and all the other presentation characteristics are identical. It also shortens the user learning time. A user recognizes the format and can instantly transfer experience with the interface he or she gained using other programs.

D. A VIRTUAL LAN

A variety of networks are available to connect computers and communications devices, each with a variety of characteristics, and each calling itself a Local Area Network. Active or passive, broadband or baseband, central or distributed control, the list of options is almost

endless. Network technology is not fully developed yet, as the C^3 Support Plan recognized in deciding not to include it in the near-term budgets. The Local Area Network we have examined to support the integration and management control goals of the Coast Guard IRM Architecture is not a specific product. The phrase is intended to describe an ability to electronically cross-connect the users, computers and communications resources of a Coast Guard District Office in a productive way. This virtual LAN should provide reasonably guaranteed delivery of information between any pair of nodes, notification of non-delivery, and an auditable record of access and use of its services.

This limited functionality is an adequate base from which to develop prototype systems or programs to satisfy the specified management control requirements, and is available at less technological risk than that a 'real' LAN represents. Shared logic word processors, such as WANG OIS-140's provide electronic mail and hardware terminal identifiers; they have been connected to the record telecommunications system in the First and the Fifth Coast Guard Districts. The Eighth and the Seventeenth Coast Guard Districts are currently running Office Automation/Word Processing evaluations on Vax 11/780 computer based systems; these also support electronic mail, and have resource usage monitor programs available. The District minicomputers scheduled for FY 86 purchase and installation could provide

this virtual LAN function through their installed terminals and the appropriate programming. Any of these systems with a sufficiently large base of connected users could provide an adequate functional base on which to prototype a system or program intended to meet one or more of the management control requirements of the IRM architecture.

E. SUMMARY

We have presented the reasons that the Coast Guard District Office is the crucial level within the IRM architecture at which to address the solution to management control requirements of that architecture. The power of a Local Area Network to physically reinforce the logical integration crucial to the IRM architecture and to the success of its management controls, was presented and examined for each of the management control requirements proposed in Chapter IV. Finally, a distinction was drawn between any specific technology or product and the virtual LAN functionality required to begin satisfying the requirements.

VI. CONCLUSION

This thesis has attempted to present a positive description of the integrative power of management control, in the setting of a large information system. We have suggested that, properly developed, the management control structure can unify diverse information systems into a single architecture, and yet preserve a powerful, if subtle, ability to influence user choices. If developed early, the control structure can ease the necessary transitions of maturing information systems.

The management control requirements proposed assume that the intention of the Office of C^3 as program managers for the IRM architecture is to integrate the separate vertical information subsystems into a cohesive whole. The proposed LAN implementation of a system to satisfy the control requirements centers on accomplishing that purpose. Both the requirements and the LAN implementation should be evaluated with this underlying assumption of integrating the architecture in mind. Both would have to be modified to support a different concept of the architecture.

This early delineation of a management control schema for the IRM architecture may have some practical significance for the U. S. Coast Guard. With major hardware and software procurements for the IRM architecture still

pending, the opportunity exists now to buy the features or capabilities that will be necessary to management control later on. More valuable than procurement opportunities may be the necessary lead time created for careful prototype development of the programs and systems that the management control structure will require.

Although the Coast Guard IRM architecture was used as a focus for development of the suggested management control structure, the requirements and implementation presented could also be applied to other information systems. The organization served by the information system would need to have sufficiently centralized control of information services that one single, or several regional offices, could set transfer prices. The company culture would have to support the notion of user autonomy within limits, and decentralized decision responsibility. The transfer pricing basis of the control strategy assumes as well that information services costs are not allocated totally as overhead, but charged to users to a significant degree.

Changing the information flows of an entire agency must change the structure, if not the nature, of the whole organization. Controlling the system which implements these changing information flows is a necessary step to insuring that the development process will one of directed growth and not uncontrolled change. This examination of management control within information systems is meant to assist the

Coast Guard and other organizations in retaining organizational control of these technology-driven changes.

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